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**Unit 4 Notes: Cellular Respiration**

Ms. Ottolini, AP Biology, 2013-2014

***Directions:*** *Use the links provided on the Wiki page to access each video. Answer the questions below thoroughly and accurately. You do not need to answer in complete sentences, however, please remember that a complete thought often requires a complete sentence! You may need to record your answers on a separate piece of paper.*

**Video #1: Life Requires Free Energy**

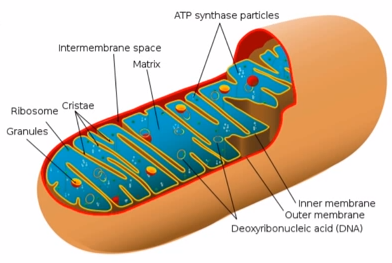
<http://www.youtube.com/watch?v=JBmykor-2kU&list=PLFCE4D99C4124A27A>

1. Where does the free energy in living organisms ultimately come from?
2. What happens to the entropy (amount of disorder) when an organism dies?
3. How do living organisms maintain order in their bodies?
4. State the First Law of Thermodynamics. What example does Mr. Anderson use to illustrate this law in nature?
5. What form does energy usually take after many energy transformations?
6. State the Second Law of Thermodynamics. Make sure to mention entropy!
7. Why do people argue that evolution “violates” the Second Law of Thermodynamics? Why is this argument invalid?
8. Glycolysis is a process used by all living organisms, indicating that there is a common ancestor for all living organisms. Glycolysis is the first step in the process of cellular respiration, the release of energy from glucose to build ATP, a more usable energy molecule. The goal of glycolysis is to break down glucose into two smaller pyruvate molecules, and create small amounts ATP and NADH (an electron carrier molecule that plays a role in a later step of cellular respiration called the electron transport chain). How can all organisms use glycolysis if they have different food sources with different sugar molecules?
9. What three life functions is free energy used for?
10. What happens if we have excess energy? What do our bodies doe with excess sugars that do not need to be broken down to create ATP? (Hint: it relates to the potato example from the video!)
11. In terms of free energy, why is it a bad thing for an ecosystem if all the trees in an area are chopped down?

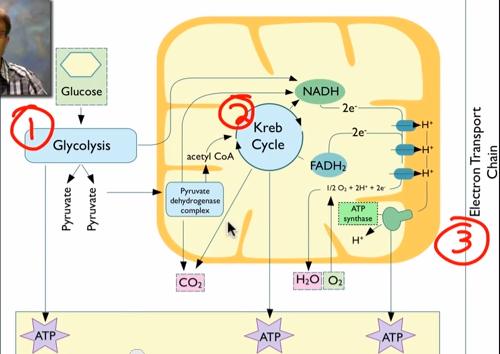
**Video #2: Cellular Respiration**

<http://www.youtube.com/watch?v=Gh2P5CmCC0M&list=PL7A750281106CD067>

1. Where does cellular respiration occur inside the cell?
2. How do bacteria perform cellular respiration if they do not have mitochondria?
3. Which organisms use cellular respiration?
4. Write out the full, balanced equation for cellular respiration.
5. The energy stored in the carbon-hydrogen bonds within glucose molecules is released during the breakdown of glucose and used to build ATP (adenosine triphosphate) from two parts – ADP (adenosine diphosphate) and Pi (inorganic phosphate). Which process—the breakdown of glucose or the synthesis of ATP—is endergonic and which is exergonic?
6. How is cellular respiration an example of energy coupling? (Note: this is NOT in the video! You will need to look back to your enzyme notes!)
7. The cell part pictured below is a mitochondrion. What evidence in the picture indicates that this was once a free-living bacteria cell?



1. The picture given below (+ half of Mr. Anderson’s face ☺) shows the overall process of cellular respiration. What are the names of the three steps involved in cellular respiration (list in order)?

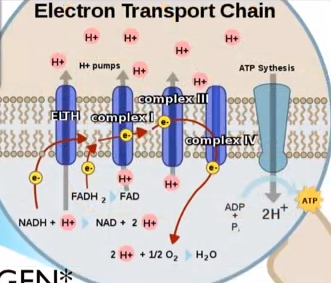


1. **Glycolysis:** What is the goal of glycolysis? Where does it take place in the cell?
2. **Glycolysis:** What two additional products are generated in the breakdown of glucose (a molecule with six carbons) to two pyruvate molecules (molecules with three carbons each)?
3. **Intermediate Step Between Glycolysis and the Kreb’s Cycle:** Once pyruvate has diffused through both membranes of the mitochondrion and entered the mitochondrial matrix (the fluid-filled space inside the folds of the inner membrane), what does pyruvate dehydrogenase (a series of three enzymes) do to the pyruvate? What products are released?
4. **Kreb’s Cycle:** During the Kreb’s cycle (AKA citric acid cycle), acetyl CoA (a molecule with two carbons) is broken down and carbon dioxide (CO2) is released. Two ATP molecules are created. Additionally, two NAD+ molecules are converted to NADH when they receive electrons and H+ from acetyl CoA. NADH is considered an electron carrier, along with another molecule—FADH2—which is also created during the Kreb’s cycle. These electron carriers transport high energy electrons to the electron transport chain where their energy will be used to generate more ATP.

The breakdown of acetyl CoA and the creation of NADH is an Oxidation-Reduction Reaction (aka a Redox reaction). In a Redox reaction, one molecule is oxidized (loses electrons) and the other is reduced (gains electrons). You can remember what occurs during oxidation and reduction using the acronym OIL RIG (Oxidation Is Loss of electrons, Reduction is Gain of electrons).

Which molecule—Acetyl CoA or NADH—is oxidized during the Kreb’s cycle? Which molecule is reduced?

1. **Electron Transport Chain:** At the beginning of the electron transport chain, where is most of the energy from glucose stored?
2. **Electron Transport Chain:** The energy from electrons “dropped off” by NADH and FADH2 is used to pump which particle across the inner membrane from the matrix to the intermembrane space using membrane protein pumps?
3. **Electron Transport Chain:** What happens to the electrons once all their energy has been used to pump protons (H+) across the inner membrane? Why do we call oxygen gas (O2) an “electron acceptor”?
4. **Electron Transport Chain:** The protons (H+) “want” to flow back across the inner membrane from a high concentration in the intermembrane space to a low concentration in the matrix of the mitochondrion. In other words, they “want” to move down their concentration gradient. They can move into the matrix through an enzyme / membrane protein called ATP synthase. Once in the matrix, these H+ can combine with the “de-energized” electrons from the Electron Transport Chain and oxygen gas (O2) to form water (H2O). As H+ flow through ATP synthase, they “turn” the protein and cause it to “squeeze” ADP and Pi together to form ATP. The use of H+ flowing down its concentration gradient to create ATP is called chemiosmosis. How many ATP are made in each of the three steps of cellular respiration?



1. When there is no oxygen present, the Kreb’s cycle and the Electron Transport Chain cannot take place. The organism must now use Anaerobic Respiration / Fermentation (the creation of ATP in the absence of oxygen) instead of Aerobic Respiration (the creation of ATP in the presence of oxygen). Anaerobic respiration involves using glycolysis to make small amounts of ATP. Why might glycolysis shut down? (Hint: think about NAD+ and NADH)
2. How does Lactic Acid Fermentation solve the NAD+ / NADH problem? What types of organisms use Lactic Acid Fermentation?
3. How does Ethyl Alcohol / Ethanol / Alcoholic Fermentation solve the NAD+ / NADH problem? What types of organisms use Alcoholic Fermentation? What other product (besides ethyl alcohol and ATP) is created during Alcoholic Fermentation?